Original Article

Assessment of Dietary Nutritional Profile in Turkish Patients with Age-Related Macular Degeneration

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Abstract

Objectives: To evaluate the dietary nutritional profile according to the suggestions of the Age-Related Eye Disease Study 2 (AREDS2) in Turkish patients with age-related macular degeneration (AMD).

Materials and Methods: The study included patients diagnosed with non-neovascular AMD in one or both eyes and who underwent routine follow-up in retina clinics at tertiary centers in İstanbul between May 12 and May 27, 2025. An ocular nutrition questionnaire prepared according to AREDS2 suggestions was translated into Turkish. The survey was conducted among our cohort after its reproducibility and validity were confirmed. Consumption of fish-shellfish, hazelnut-walnut-peanut, eggs, leafy greens, red pepper, carrot-pumpkin, and peppers-green tea-strawberry-citrus (eicosapentaenoic acid, docosahexaenoic acid, omega 3, lutein, zeaxanthin, beta-carotene, and antioxidant-rich foods, respectively), micronutrient supplementation, smoking, physical activity, anxiety about vision loss, education level, and monthly income were recorded.

Results: A total of 530 patients from 7 clinics who answered all questions were evaluated. Adequate consumption of omega-3-rich foods consumption was reported by 19.3% of participants, whereas 57.2% reported no fish intake in the last week. Adequate consumption of foods rich in lutein/zeaxanthin, beta-carotene, and antioxidants was reported by 63.6%, 41.7%, and 4.7% of patients, respectively, and regular micronutrient supplementation was reported by 35.5%. Of the patients, 23.6% reported high anxiety about vision loss, 69.8% reported elementary or lower education, and 64.9% had a 20,000 TRY or lower monthly income. Micronutrient intake was positively associated with anxiety (p=0.0001) and education (p=0.02) but not with monthly income (p=0.1).

Conclusion: According to this first report in Turkish patients with AMD which was evaluated nutrition profile based on AREDS2 suggestions, patients showed low adherence to AREDS recommendations for micronutrient intake and lifestyle modifications. Awareness among patients and ophthalmologists needs improvement.

Keywords: Age-related macular degeneration, dietary nutrition, micronutrition

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Introduction

Age-related macular degeneration (AMD) is a leading cause of vision loss in older adults, and preventing blindness due to AMD is becoming increasingly important as the global population ages.[1] Treatment with anti-vascular endothelial growth factor is effective in treating the neovascular form of AMD; however, there is no reliable treatment for non-neovascular AMD.

The Age-Related Eye Disease Study (AREDS) showed that high doses of vitamins C and E, beta-carotene, and zinc supplements could reduce the risk of developing advanced AMD by 25% after 5 years.[2] AREDS2 evaluated the effect of adding lutein plus zeaxanthin and omega-3 long-chain polyunsaturated fatty acids to the AREDS formulation in further reducing the risk of progression to advanced AMD. According to the exploratory analysis of AREDS2, protection against progression to AMD was observed in patients with the lowest dietary intake of lutein plus zeaxanthin.[3] Moreover, healthy lifestyle behaviors, such as a nutritious diet, physical activity, and avoidance of smoking, were associated with 71% lower odds of developing AMD.[4]

Dietary supplementation is currently considered the only effective means of preventing progression to advanced forms of AMD. Nevertheless, adherence to AREDS recommendations seems unsatisfactory. Several studies have evaluated adherence to AREDS recommendations in different countries.[5,6,7,8] However, there are no published data concerning the Turkish population. Therefore, we aimed to evaluate the dietary nutritional profile of Turkish patients with AMD according to the AREDS2 recommendations and determine the extent of adherence to AREDS2 nutritional and lifestyle recommendations.

Materials and Methods

This multicenter cross-sectional study protocol was approved by the Institutional Review Board of University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital (protocol number: 2025/121, decision no: 2025-08-03, date: 04/24/2025) and was conducted in accordance with the principles outlined in the Declaration of Helsinki. Informed consent was obtained from all participants. Patients diagnosed with non-neovascular AMD in one or both eyes and examined during routine follow-up visits in retina clinics at seven education and research hospitals in İstanbul between May 12 and May 27, 2025, were included.

An ocular nutrition questionnaire developed in accordance with AREDS2 dietary recommendations was translated into Turkish and adapted for this study (Table 1).[9] First, the survey was conducted with five patients in each research clinic as a pilot study to evaluate readability, clarity, and reliability. We also assessed face validity through pilot testing.[10] After reproducibility was observed, the survey was administered to our cohort. Consumption of fish/shellfish, nuts/walnuts/peanuts, eggs, leafy greens, red pepper, carrot/pumpkin, peppers/green tea/strawberry/citrus (foods rich in eicosapentaenoic acid [EPA], docosahexaenoic acid [DHA], omega-3, lutein, zeaxanthin, beta-carotene, and antioxidants), micronutrient supplement use, systemic diseases, smoking status, physical activity, anxiety about vision loss, education level, and monthly income were recorded. The patient's age, diagnosis, and follow-up duration were also recorded.

Statistical Analysis

All statistical analyses were performed using IBM SPSS for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequencies and percentages for categorical variables. Associations between micronutrient supplement intake and categorical variables, including anxiety level, education level, and monthly income, were evaluated using the chi-square test or Fisher's exact test where appropriate. The level of statistical significance was set at $p<0.05$.

Results

In total, 530 patients who answered all questions were evaluated. Demographic and clinical data are summarized in Table 2.

Of the 530 respondents, an average of 19.3% reported adequate consumption of omega-3-rich foods according to AREDS recommendations, and 57.2% reported no fish intake in the previous week. Adequate consumption of foods rich in lutein/zeaxanthin, beta-carotene, and antioxidants was reported by 63.6%, 41.7%, and 4.7% of respondents, respectively. The results are summarized in Table 3.

Additionally, 35.5% of the participants reported regular use of micronutrient supplements and 26.8% reported regular physical activity. High anxiety about vision loss (score of 5) was reported by 23.6%. Of our cohort, 69.8% had a low education level (illiterate or primary school graduate), and 64.9% reported a monthly income of 20,000 TRY or less.

In the cross-tabulation analysis, a significant positive association was observed between micronutrient intake and both anxiety grade ($p=0.0001$) and education level ($p=0.02$). In addition, dietary modification after AMD diagnosis was significantly associated with both anxiety and education levels (both $p=0.001$). No significant relation was found between micronutrient intake and monthly income ($p=0.1$). However, fish consumption was positively

Table 1. Ocular nutrition questionnaire					
Please think a moment to reflect on what you ate last week and then answer the questions.					
	None	**1-2**	**3-4**	**5 or more**	
Sardines, mackerel, trout, salmon per week (1 fillet the size of a deck of cards)					
Shellfish (mussel, lobster, oysters) per week					
Walnut per week (2 walnuts)					
Egg per week (1 egg)					
Kale, spinach, broccoli, chard, lettuce, arugula per week (1 handful raw, 1 cup cooked)					
Red pepper per week (1/2 pepper)					
Carrots, pumpkin, sweet potato, turnip per week (1 cup)					
Hazelnut, peanut, almond per week (10 in a day)					
	Less than 8	**8-15**	**15 or more**		
Peppers, green tea, strawberry, kiwi, citrus per week (1 medium fruit or 1 cup)					
Do you follow a special diet?	No	Vegan	Gluten-free		
Do you take any special supplements, such as turmeric, saffron, maqui berry, grape seed	Yes	No			
Do you use any supplement for your AMD?	No	Not regularly	Regularly		
Systemic diseases	Diabetes	Hypertension	Hyperlipidemia		
Physical activity (at least 1 hour walking in a day)	None	Not regularly	Regularly (at least 3 days)		
Are you a current smoker?	No	Yes	…. pack(s)/day		
Are you an ex-smoker?	No	Yes	…. years		
Did you make any change to your diet after being diagnosed with AMD?	Yes	No			
Do you have anxiety about loss of your sight? Please rate your anxiety from 0 = none to 5 = severe ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5					
Education level	Illiterate				
	Elementary school	Middle school	High school		
	University	Postgraduate			
Monthly income	Under 20,000 TRY 20,000–50,000 TRY 50,000–100,000 TRY Over 100,000 TRY				

associated with monthly income and education level (p=0.0001 and p=0.004, respectively). Micronutrient intake and post-diagnosis diet modification were more frequent in female patients; however, the difference was not significant (p=0.05 and p=0.3, respectively).

According to fellow eye status, nut and egg consumption was significantly more common among patients with neovascular disease in the fellow eye (p=0.04 and p=0.001, respectively). This group also reported higher anxiety grade and a higher frequency of regular exercise (p=0.001 for both). Micronutrient supplementation and the use of additional supplements (e.g., turmeric/saffron) were significantly associated with neovascular AMD in the fellow eye (p=0.002 and p=0.026, respectively).

Discussion

To the best of our knowledge, adherence to the AREDS2 recommendations and lifestyle modifications in AMD has not yet been studied in the Turkish population. This study offers valuable insights into the nutritional habits

Table 2. Demographic and clinical data		
Age (years), mean ± SD, (range)		70.8±8.7 (43-97)
Follow-up time (months), mean		31.7
		Patients, n (%)
Fellow eye	Non-neovascular Neovascular	392 (74.0) 138 (26.0)
Stage of AMD	Intermediate Late	411 (77.5) 119 (22.5)
Gender	Female Male	299 (56.4) 231 (43.6)
SD: Standard deviation, AMD: Age-related macular degeneration		

and lifestyle characteristics of Turkish patients with AMD evaluated in the context of the AREDS2 recommendations. Our findings revealed suboptimal dietary patterns, particularly concerning intake of foods rich in omega-3 fatty acids, lutein/zeaxanthin, and antioxidants, as well as suboptimal micronutrient intake, which may have implications for disease progression and visual prognosis.

The relatively low frequency of omega-3-rich food consumption (19.3%), along with the fact that over half of the patients reported no fish intake during a typical week, aligns with existing evidence suggesting that Westernized or urban dietary patterns often lack sufficient long-chain polyunsaturated fatty acids, such as EPA and DHA. These essential fatty acids play critical roles in retinal integrity and anti-inflammatory mechanisms, potentially slowing the progression of AMD.[11,12] Despite moderate levels of lutein/zeaxanthin intake (63.6%), only a small proportion of participants reported adequate consumption of antioxidant-rich foods (4.7%). This finding is notable, considering that lutein and zeaxanthin are the primary macular pigments and enhance visual function and reduce oxidative stress.[13,14] Moreover, low antioxidant intake can compromise the ability of the macula to mitigate oxidative damage, which contributes to the pathogenesis of AMD.[15]

Regular micronutrient supplement usage was reported by only 35.5% of the participants, which appears insufficient when considering the robust evidence supporting the benefits of the AREDS and AREDS2 formulations in reducing the risk of AMD progression.[2,3] Similar survey-based studies from different countries reported micronutrient usage rates ranging from 38% to 83%.[4,5,14] More specifically, a study conducted in the USA found a rate of micronutrient intake of 42.5%, and a different study from the USA reported that 81% of patients had modified their diet according to the retina specialist's recommendations.[6,7] However, a 0% rate of smoking cessation was reported in the latter study. In a study from Italy, the researchers reported an AREDS-type oral supplementation rate of 40%.[8] The relatively lower adherence to micronutrient supplementation in our study may be associated with limited awareness, cost barriers, or a lack of physician recommendations, particularly in patients with lower socioeconomic and educational backgrounds.

A significant association was observed between micronutrient intake and both education level and anxiety regarding vision loss. Patients with lower education levels were less likely to consume recommended supplements, which may reflect the disparities in health literacy and access to nutritional information. Furthermore, participants with higher anxiety levels were more likely to use supplements, indicating self-initiated efforts to prevent visual deterioration. These findings are consistent with those of previous studies linking higher health-related anxiety to proactive health behaviors.[16,17]

Physical activity was also suboptimal (26.8%), despite growing evidence that an active lifestyle may be protective against AMD progression, possibly through systemic anti-inflammatory effects and enhanced vascular health.[18]

Some significant differences were found according to the status of fellow eye. Patients with neovascular involvement in the fellow eye were more likely to report higher consumption of eggs and nuts, regular exercise, micronutrient supplementation, the use of additional products such as turmeric or saffron, and higher anxiety, which may reflect increased disease awareness and perceived risk of visual loss. This heightened concern could also explain the greater adoption of health-related behaviors observed in this group. However, it remains unclear whether these habits were adopted earlier but were insufficient to mitigate disease progression, or represent adaptive responses after the diagnosis of advanced disease.

No significant correlation was found between monthly income and micronutrient intake. This finding could reflect the relative affordability of basic AREDS2 supplements in Türkiye or may indicate that non-economic barriers, such as education, awareness, or cultural factors, play a more prominent role.

Table 3. Nutrition profile and lifestyle characteristics of the participants according to AREDS2 recommendations (indicated by asterisks)

	None	1-2 days	3-4 days*	5 days or more*
Omega-3-rich foods				
Sardines, mackerel, trout, salmon	303 (57.2%)	194 (36.6%)	22 (4.2%)	11 (2.1%)
Shellfish (mussels, lobster, oysters)	519 (97.9%)	9 (1.7%)	2 (0.4%)	0 (0%)
Walnuts	109 (20.6%)	247 (46.6%)	99 (18.7%)	75 (14.2%)
Hazelnuts, peanuts, almonds	181 (34.2%)	244 (46%)	59 (11.1%)	46 (8.7%)
Lutein-rich foods				
Kale, spinach, broccoli, chard, lettuce, arugula	22 (4.2%)	185 (34.9%)	199 (37.5%)	124 (23.4%)
Egg	12 (2.3%)	166 (31.3%)	142 (26.8%)	210 (39.6%)
Zeaxanthin-rich foods				
Red pepper	199 (37.5%)	214 (40.4%)	65 (12.3%)	52 (9.8%)
Beta-carotene rich foods				
Carrots, pumpkin, turnip	74 (14.0%)	235 (44.3%)	152 (28.7%)	69 (13.0%)

Antioxidant-rich foods Peppers, green tea, strawberry, kiwi, citrus, other fruit	**<8** 395 (74.5%)	**8-14** 110 (20.8%)	**15*** 25 (4.7%)
Special diet	**No** 514 (97%)	**Vegan** 4 (0.8%)	**Gluten-free** 12 (2.3%)
Micronutrition usage	**None** 181 (34.2%)	**Not regularly** 161 (30.4%)	**Regularly*** 188 (35.5%)
Any special supplements as turmeric, saffron, maqui berry, grape seed	**No** 466 (87.9%)	**Yes** 64 (12.1%)	
Changed diet after AMD diagnosis	**No** 420 (79.2%)	**Yes** 110 (20.8%)	
Physical activity	**None** 228 (43.0%)	**Not regularly** 160 (30.2%)	**Regularly** 142 (26.8%)
Current smoker	**No** 455 (85.8%)	**Yes** 75 (14.2%)	
History of smoking	**No** 341 (64.3%)	**Yes** 189 (35.7%)	

Systemic diseases	**None** 166 (31.3%)	**DM** 68 (12.8%)	**HT** 104 (19.6%)	**HL** 20 (3.8%)
	DM+HT 72 (13.6%)	**DM+HL** 12 (2.3%)	**HT+HL** 37 (7%)	**DM+HT+HL** 51 (9.6%)

Anxiety about vision loss	**0** 73 (13%)	**1** 54 (10%)	**2** 63 (11%)	**3** 112 (21%)	**4** 103 (19%)	**5** 125 (23%)
Education level	**Illiterate** 78 (14%)	**Primary** 292 (55%)	**Elementary** 87 (16%)	**High Sch.** 50 (9%)	**University** 19 (3%)	**Postgrad.** 4 (0.8%)

Monthly income	**<20k TRY** 344 (64.9%)	**20-50k TRY** 167 (31.5%)	**50-100k TRY** 15 (2.8%)	**>100k TRY** 4 (0.8%)

AMD: Age-related macular degeneration, DM: Diabetes mellitus, HT: Hypertension, HL: Hyperlipidemia, TRY: Turkish lira

Study Limitations

This study has several limitations that should be acknowledged. First, as a questionnaire-based survey, the findings rely on self-reported data, which may be subject to recall bias and reporting inaccuracies. However, there is currently no other practical and easily applicable method to comprehensively assess dietary habits and lifestyle behaviors in such a large patient population. Second, the

study population consisted of patients residing in Istanbul, which may limit the generalizability of the results to the entire Turkish population. Nevertheless, Istanbul is a highly cosmopolitan city with diverse socioeconomic and cultural characteristics, and the findings are therefore likely to provide valuable insight into national trends. Third, seasonal variations in dietary habits may have influenced the results. For example, fish consumption may be lower during the summer months, when this study was conducted. Also, the absence of a subgroup analysis according to AMD stage is another limitation. Considering these factors, future studies including different seasons and a broader, nationwide population would be beneficial to further validate and expand upon the present findings.

Conclusion

Our findings highlight the urgent need for structured nutritional education and personalized counseling for patients with AMD. Ophthalmologists should be encouraged to integrate dietary and lifestyle guidance into AMD management protocols, especially in high-risk populations. In addition to having a duty of care to treat the neovascular complications of AMD as ophthalmologists, we must also strive to improve its prevention.

Ethics

Ethics Committee Approval: This multicenter cross-sectional study protocol was approved by the Institutional Review Board of University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital (protocol number: 2025/121, decision no: 2025-08-03, date: 04/24/2025) and was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Informed Consent: Informed consent was obtained from all participants.

Declarations

Authorship Contributions

Surgical and Medical Practices: B.D., H.N.T., S.Ö.E., A.A., M.K., M.E., T.U., T.A.G., A.Ç., N.S., S.A.Ö., Ö.A.O., E.B., M.Ö., Concept: A.Ö., A.Ç., N.S., S.A.Ö., Ö.A.O., E.B., B.D., M.Ö., Design: B.D., H.N.T., S.Ö.E., A.A., M.K., M.E., T.U., T.A.G., Data Collection or Processing: B.D., H.N.T., S.Ö.E., A.A., M.K., M.E., T.U., T.A.G., A.Ç., N.S., S.A.Ö., A.Ö., E.B., M.Ö., Analysis or Interpretation: A.Ö., A.Ç., N.S., S.A.Ö., Literature Search: B.D., H.N.T., S.Ö.E., A.A., M.K., M.E., T.U., T.A.G., Writing: B.D., H.N.T., S.Ö.E., A.A., M.K., M.E., T.U., T.A.G., A.Ç., N.S., S.A.Ö., Ö.A.O., E.B., M.Ö., A.Ö.

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